Entergy

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September 22, 2005
BVY 05-087

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

**Subject:** **Vermont Yankee Nuclear Power Station**
**License No. DPR-28 (Docket No. 50-271)**
**Reportable Occurrence No. LER 2005-001-00**

As defined by 10 CFR 50.73(a)(2)(iv)(A), we are reporting the attached Reportable Occurrence that occurred on July 25, 2005 as LER 2005-001-00. No Regulatory Commitments have been generated as a result of this event.

Sincerely,

**Entergy Nuclear Operations, Inc.**
**Vermont Yankee**

William F. Maguire
General Manager, Plant Operations

cc: USNRC Region I Administrator
USNRC Resident Inspector - VYNPS
USNRC Project Manager - VYNPS
Vermont Department of Public Service

IE22

NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 06/30/2007

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by Internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

# LICENSEE EVENT REPORT (LER)

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**4. TITLE**

Reactor Trip Caused by an Electrical Insulator Failure in the 345 kV Switchyard due to a Manufacturing Defect

| 5. EVENT DATE | | | 6. LER NUMBER | | | 7. REPORT DATE | | | 8. OTHER FACILITIES INVOLVED | |
|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REV NO. | MONTH | DAY | YEAR | FACILITY NAME | DOCKET NUMBER |
| | | | | | | | | | N/A | 05000 |
| 07 | 25 | 2005 | 2005 | - 001 - | 00 | 09 | 22 | 2005 | FACILITY NAME: N/A | DOCKET NUMBER: 05000 |

**9. OPERATING MODE**

N

**10. POWER LEVEL**

100

**11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)***

| | | | |
|---|---|---|---|
| ☐ 20.2201(b) | ☐ 20.2203(a)(3)(i) | ☐ 50.73(a)(2)(i)(C) | ☐ 50.73(a)(2)(vii) |
| ☐ 20.2201(d) | ☐ 20.2203(a)(3)(ii) | ☐ 50.73(a)(2)(ii)(A) | ☐ 50.73(a)(2)(viii)(A) |
| ☐ 20.2203(a)(1) | ☐ 20.2203(a)(4) | ☐ 50.73(a)(2)(ii)(B) | ☐ 50.73(a)(2)(viii)(B) |
| ☐ 20.2203(a)(2)(i) | ☐ 50.36(c)(1)(i)(A) | ☐ 50.73(a)(2)(iii) | ☐ 50.73(a)(2)(ix)(A) |
| ☐ 20.2203(a)(2)(ii) | ☐ 50.36(c)(1)(ii)(A) | ☑ 50.73(a)(2)(iv)(A) | ☐ 50.73(a)(2)(x) |
| ☐ 20.2203(a)(2)(iii) | ☐ 50.36(c)(2) | ☐ 50.73(a)(2)(v)(A) | ☐ 73.71(a)(4) |
| ☐ 20.2203(a)(2)(iv) | ☐ 50.46(a)(3)(ii) | ☐ 50.73(a)(2)(v)(B) | ☐ 73.71(a)(5) |
| ☐ 20.2203(a)(2)(v) | ☐ 50.73(a)(2)(i)(A) | ☐ 50.73(a)(2)(v)(C) | ☐ OTHER |
| ☐ 20.2203(a)(2)(vi) | ☐ 50.73(a)(2)(i)(B) | ☐ 50.73(a)(2)(v)(D) | Specify in Abstract below or in NRC Form 366A |

**12. LICENSEE CONTACT FOR THIS LER**

| CONTACT NAME | TELEPHONE NUMBER *(Include Area Code)* |
|---|---|
| William F. Maguire, General Manager Plant Operations | (802) 257-7711 |

**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**

| CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX | CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX |
|---|---|---|---|---|---|---|---|---|---|
| B | FK | INS | L085 | Y | B | FK | MOD | S318 | Y |

**14. SUPPLEMENTAL REPORT EXPECTED**

○ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ◉ NO

**15. EXPECTED SUBMISSION DATE**

| MONTH | DAY | YEAR |
|---|---|---|
| | | |


ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

On July 25, 2005 at 1525, with the reactor at full power, a generator load reject trip and subsequent reactor trip occurred as a result of an electrical transient that originated in the 345 kV Switchyard. The electrical transient was due to a failure of the 345 kV Motor Operated Disconnect (MOD) Switch, T-1, "C" phase that was caused by the failure of an electrical insulator. An off-site laboratory performed an examination of the porcelain insulator revealing that the failure was caused by a manufacturing defect. The appropriate NRC 4-hour notifications were completed at 1735 in accordance with 10 CFR 50.72(b) as NRC Event Number 41868. This event is being reported as an LER pursuant to 10 CFR 50.73(a)(2)(iv)(A) as an event that resulted in the automatic actuation of systems listed within 10 CFR 50.73(a)(2)(iv)(B). Plant equipment and operator response to the event was as expected, and the reactor was shutdown with no complications. No release of radioactivity or personnel injury occurred as a result of this event. Therefore, this event did not increase the risk to the health and safety of the public.

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**17. NARRATIVE** *(If more space is required, use additional copies of NRC Form 366A)*

DESCRIPTION:

On July 25, 2005 at 1525 with the reactor at full power, a generator load reject trip and reactor scram occurred due to an electrical transient that originated in the 345 kV Switchyard. An electrical insulator [EIIS=INS, FK] failed, causing a failure of the "C" phase on the 345 kV Motor Operated Disconnect (MOD) Switch T-1 [EIIS=, MOD,FK] ultimately leading to a reactor scram. The plant was placed in a stable condition and reactor water level was restored to its normal band within 25 seconds of the condition that promulgated the event. Plant equipment and operator response to the event was as expected and the reactor was shutdown with no complications. The appropriate NRC 4 hour notifications were completed at 1735 in accordance with 10CFR50.72(b) as NRC Event Number 41868. This event is being reported as an LER pursuant to 10CFR50.73(a)(2)(iv)(A) as an event that resulted in the automatic actuation of systems listed within 10CFR50.73(a)(2)(iv)(B).

The T-1 MOD is physically located between the 345 kV windings of the Main Transformer and the Main Generator output breakers 1T and 81-1T. The electrical insulator that failed was located on the line side of T-1 MOD, providing support for the "C" phase of T-1 MOD. The insulator that failed was manufactured by Lapp Insulator Company, Model J80104-70 Post Stack Insulator, Drawing 3597-51, R0.

Following the plant trip, interviews were conducted with personnel who observed the 345 kV Switchyard events as they transpired, thereby supporting the following conclusions:

1. Arcing occurred at the "C" phase of the T-1 MOD switch.
2. Part of the T-1 MOD switch fell, resulting in a number of audible sounds.
3. Flashes occurred while the T-1 parts fell.
4. The 345 kV high line between the tower and the 345 kV Switchyard moved up and down after the insulator fell.
5. T-1 MOD opened after the fault occurred.

During the first 14 seconds of the event, the following automatic system responses occurred as designed without operator intervention. Action times are provided in the brackets succeeding each item where appropriate:

1. The "C" Phase 87/TL1 Differential Relay senses the development of a "C" Phase to Ground Fault that is a result of the arcing at the T-1 disconnect caused by the insulator failure.
2. The Generator 86/TL1 Tie Line Lockout Relay actuated due to a trip signal from the associated "C" Phase 87/TL1 Differential Relay. [T=0]
3. Main Generator Breakers 81-1T and 1T open from the 86/TL1 signal, isolating the fault from the 345/115 kV system. [T=30 to 33 milliseconds]
4. 4 kV Bus 1 and 2 High Speed Synch Check Relays 25/1 and 25/2 indicated a loss of synchronism between the Auxiliary and Startup Transformers. As designed, this blocks a Fast Transfer of station loads to the Startup Transformers as necessary to prevent possible equipment damage that could occur due to an out-of-phase transfer. [T=33 milliseconds]
5. Generator Primary Lockout Relay Trip indication received on ERFIS. [41 milliseconds] NOTE: The Lockout Relay to ERFIS is received via an auxiliary relay, therefore the trip actually occurred 10 milliseconds before the indication was received.
6. Turbine Trip is actuated by a Main Generator Lockout Relay. [T=90 milliseconds]
7. Both channels of the Reactor Protection System (RPS) are received for a full Reactor SCRAM - all rods fully inserted. The ERFIS sequence of events log indicates that the Main Generator Load Reject Scram Signal was received just prior to the Turbine Stop valve Closure Signal. [T=136 milliseconds] RPS system actuation is reportable to the NRC as an LER pursuant to 10CFR50.73(a)(2)(iv)(A).
8. "A" and "C" Reactor Feedwater Pumps are automatically tripped by the 4 kV Bus Fast/Residual Transfer Scheme. This occurs as a result of the Startup Transformer Breakers not closing within 0.3 seconds of the opening of the Auxiliary Transformer Breakers. Reactor Feedwater Pump trips are expected on a Residual Bus Transfer. [T=350 milliseconds]

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9. Breakers 13 and 23 close to re-energize Bus 1 and 2 after bus voltage has decayed to 1000 volts. [T=623-705 milliseconds]
10. "A" Service Water Pump Starts. [T=1 second]
11. "B" Standby Gas Treatment System (SBGT) starts as a result of the Residual Bus Transfer. [T=2 seconds]
12. Reactor Water Level Low (127") Scram Signal initiates a Primary Containment Isolation System (PCIS) Group 2,3 and 5 Isolation. [T=5.5 seconds] PCIS actuation is reportable to the NRC as an LER pursuant to 10CFR50.73(a)(2)(iv)(A).
13. "A" SBGT System starts on a Reactor Water Low Level Signal. [T=7 seconds]
14. The 4 kV Supply Breaker to the "B" Recirculation Motor Generator (MG) trips on MG system oil pressure following a six second delay in MG control logic. [T=8 seconds]
15. Reactor Low-Low Water Level (82.5") and PCIS Group 1 Isolation. The following system actions occurred for the Group 1 Isolation; Main Steam Isolation Valves (MSIVs) closed, Reactor Core Isolation Cooling (RCIC) System start and inject signal, High Pressure Coolant Injection (HPCI) system start and inject signal, both Emergency Diesel Generators started (running unloaded), and the "A" Recirculation Pump MG Supply Breaker tripped. [T=14 seconds]

PCIS actuations are reportable to the NRC as an LER pursuant to 10CFR50.73(a)(2)(iv)(A). The NRC was notified of the PCIS actuation 10CFR50.72(b)(3)(iv)(A).

ECCS actuations are reportable to the NRC as an LER pursuant to 10CFR50.73(a)(2)(iv)(A). The NRC was notified of this event per 10CFR50.72(b)(3)(iv)(A) and 10CFR50.72(b)(2)(iv)(A)

The following operator actions were taken to stabilize the plant:

1. Placed the Mode Switch to Shutdown. [T=21 seconds]
2. Started "B" Reactor Feedwater Pump to re-establish normal level control. [T=25 seconds]

Within 25 seconds following the operator actions, all reactor water low level alarms were clear.

At 2248, Operations documented that HPCI, RCIC, SBGT, and both EDGs had been secured and returned to standby status. Operations then commenced cool down of the reactor.

ANALYSIS:

The events detailed in this report did not have adverse safety implications. The 4 kV Bus Fast/Residual Transfer Scheme operated as designed to secure and transfer electrical loads as necessary to prevent damage to equipment. The Reactor Protection System operated as designed and scrammed the reactor after receiving the Generator Load Reject Scram signal. All other safety systems responded as expected.

An off-site laboratory performed an examination of the porcelain insulator revealing that the failure was caused by a manufacturing defect located below the top of the cemented joint obscuring visual inspection. The lab determined that the defect was not detectable by visual inspection or predictive maintenance. The failure was found to be structural and evidence of a dielectric breakdown was not present; therefore, predictive maintenance techniques, such as corona, acoustic and thermography would not have detected the failure.

CAUSE:

A root cause investigation team determined that the MOD failure was caused by the failure of a porcelain electrical insulator as a result of a manufacturing defect. A laboratory examination of the insulator was performed by an off-site lab. The examination revealed a void area in the cement that attached the failed section of the insulator to the metal flanges and a geometric off-set in the placement of the insulator in the flanges. Close examination of the void

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surfaces showed that this void was pre-existing and occurred during the manufacturing of the assembly. These conditions caused a stress riser to occur on the northwest side when wind and other cyclic loads were applied to the Insulator. The repeated cyclical loading and unloading produced a stress crack in the porcelain, weakening the insulator and ultimately leading to failure, prior to it's design lifetime of 40 years. The insulator was original plant equipment.

CORRECTIVE ACTIONS:

1. Failed components in the 345 kV Switchyard were tagged out, grounded and replaced.
2. Visual, thermography and corona inspections of the 345 kV and 115 kV Switchyards was performed. No additional anomalies were identified. The inspections included components such as bus work, disconnect switches, insulators, etc.
3. Testing was performed to evaluate any potential impact on the Main Transformer and found acceptable.
4. The 345 kV high line section between the tower and Switchyard was inspected and found acceptable (that included insulators, disconnects, bus work, etc.).
5. Other T-1 MOD, 1T-22 and 1T-11 insulators were inspected for damage, and none was found.
6. Preliminary lab analysis of failed components was performed.
7. The five remaining Lapp Model J80104-70 insulators on the line and load ends of the T-1 disconnect switch are scheduled for further inspection and replacement during the Fall 2005 scheduled outage (RF-25). Laboratory analysis will be performed on the insulators removed.
8. Insulators in the Switchyard that pose a risk to generation or potential for a loss of off-site power will be evaluated for replacement.
9. The preventative maintenance frequency for the 345 kV and 115 kV Disconnect Switches and Vertical Bus Insulators will be revised. VY will also ensure that the visual inspection attributes include the flange to porcelain cemented joints and entails inspecting for voids, cracks and off-center assemblies.

ASSESSMENT OF SAFETY CONSEQUENCES:

The reactor was safely shutdown without complications. No failure of safety related equipment occurred during or as a result of this event. The T-1 MOD disconnect is a non-safety related component and is not relied upon for the safe shutdown of the plant; hence, there was no impact on nuclear safety. Mitigating safety systems and non-safety systems responded as designed. A reactor trip with a Primary Containment Isolation System (PCIS) Group 1 isolation, concurrent with a loss of feed water is an analyzed event. The T-1 MOD is physically located in the 345 kV Switchyard, outside of the Radiological Controlled Area (RCA). There was no increased radiological risk to plant personnel or the general public.

ADDITIONAL INFORMATION

A similar event occurred on 03/13/91 at VY that was reported to the NRC as LER 91-005-00 on 04/12/91, "Reactor Scram due to Mechanical Failure of 345 kV Switchyard Bus caused by Broken High Voltage Insulator Stack". The root cause of the bus failure was attributed to a loose bus connection at the lower insulator stack between the bus and the tower. Off-site lab analysis of the fractured insulator completed during the two months succeeding the event were inconclusive. The remaining intact pieces were subjected to specific gravity and dye penetration testing in addition to visual examination and mechanical testing for strength versus rating. Other than some evidence of sand-glaze separation on the porcelain surface within the cap, it was determined that the insulator had been properly fired and that no porosity was present. No defects were discovered and the insulator was demonstrated as capable of performing within its designed rating.